

Remarks

Claims 1-69 are pending in the present application. Reconsideration is respectfully requested.

Claim Rejection under 35 USC § 112, First Paragraph

Claims 63-65 have been amended to include the term -- electrolytically -- in the body of the claim rather than the preamble. As is the case under the law, whether this term is recited in the body or the preamble as in these particular claims, the limitation is the same. Although we disagree with the Examiner that such language must be in the claim body, since it does not change the scope of the claims, claim 63 has been so amended.

Claim Rejections under 35 USC § 112, Second Paragraph

Although the Applicants believe that the Examiner's rejections under § 112 are improper - as each claim is sufficiently clear as prescribed by the law - because the requested amendments do not narrow the scope of any of the claims and in order to move this application forward to issuance or appeal, Applicants have amended the claims as requested by the Examiner.

Claim Rejections under 35 USC § 103(a) Based on Primary Reference Reid (6,793,796)

Claims 1-5 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Reid USP 6,024,857. This rejection is traversed.

The Examiner's Obviousness Rejections were Before and are Again Rebutted with the Unexpected Superior Results as Evidenced in the Comparison Data in Specification and by the Teaching Away of the Prior Art References As Well

As stated before, the cited references neither teach nor suggest the presently claimed compositions or methods. As explained below, that is because the single reference point in the cited art referred to by the Examiner discloses only exceptionally broad genus copper and acid composition ranges while that same art actually teaches away from the presently claimed carefully crafted narrow species copper to acid relative ranges disclosed in the present application. Although the broad ranges cited by the examiner may be sufficient to initially support a *prima facie* showing of obviousness, that presumption is a rebuttable presumption

through a showing of (1) unexpected superior results in the present application or (2) a teaching away in the cited reference(s).

The Examiner has not properly considered and applied the rebuttal evidence pointed out; when such evidence is considered it is clear that the obviousness rejection should be withdrawn. Furthermore, the Examiner has failed to appreciate the criticality of and the unexpected results achieved by the claimed combination relative ranges of copper to acid. The present invention has enabled electrolytic deposition of submicron devices while virtually eliminating or eliminating the voids and other debilitating defects encountered when electrodeposition occurs with the existing compositions, including the compositions actually suggested and taught by Reid. In addition, while reciting that a reference must be considered as a whole and thus referring to the broad ranges set forth in the cited reference, the Examiner fails to likewise consider the specific teaching away in the reference where the *only* relative ranges of copper to acid were disclosed.

Prior Art Broadly Disclosed Composition Ranges Do NOT Per Se Make Obvious Narrow Disclosed Composition Relative Ranges

It is well established law that the disclosure of a genus in the prior art is not necessarily a disclosure of every species that is a member of that genus. See, e.g., *In re Baird*, 16 F.3d 380, 382 (Fed. Cir. 1994). There may be many species encompassed within a genus that are not disclosed by a mere disclosure of the genus. For example, the Federal Circuit has just held in *Atofina v. Great Lakes Chem. Corp.*, 05-1359 (Fed. Cir., March 23, 2006), that a disclosed temperature range of over 100 degrees was not a small genus and did not teach or suggest the temperature range claimed in the subject application.

Just because a claimed range falls within a prior art reference broad or genus range does not make the narrow claimed ranges *per se* obvious. Both the broad range composition (the genus) and the narrow range compositions (the species) can be patentable. *Atofina* (Fed. Cir. March 2006). Although the prior art broader ranges disclosure may support a *prima facie* showing of obviousness, this is a rebuttable presumption.

A Prima Facie Case of Obviousness as Allegedly Asserted by the Examiner is Rebuttable with Unexpected Superior Results or with a Showing that the Prior Art Teaches Away

Under the law, a prima facie case of obviousness as presented by the Examiner can be overcome in at least two different ways. MPEP §§ 716.02(a) and 2144.05. Applicants presented evidence of both in the application and the last Amendment filed and does so yet again below since the Examiner has failed to consider this evidence in either Office action.

(1) The presumption can be rebutted by establishing "that the [claimed] range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range." In re Geisler, 116 F.3d at 1469-70, 43 USPQ2d at 1365 (Fed. Cir. 1997). See also In re Antonie, 559 F.2d 618, 620, 195 USPQ 6, 8 (CCPA 1977); In re Malagari, 499 F.2d 1297, 182 USPQ 549 (CCPA 1974) (recognizing that "ranges which overlap or lie inside ranges disclosed by the prior art may be patentable if the applicant can show criticality in the claimed range by evidence of unexpected results" and that "unexpectedly good results where variables are optimized may be patentable").¹

or

(2) The presumption of obviousness can be overcome by showing how the reference teaches away from the narrower claimed relative ranges compositions, in any material respect. In re Geisler, 116 F.3d at 1469-70, 43 USPQ2d at 1365 (quoting In re Malagari, 499 F.2d 1297, 182 USPQ 549 (CCPA 1974)).

Unexpected Superior Results as Compared to the Prior Art Compositions Such as Disclosed in the Reid Reference, are Shown in the Present Application Specification

Claims 1-5 of the present application recite in part, a composition comprising about 35 to about 60 g/L copper and about 65 to about 150 g/L sulfuric acid. These carefully defined ranges recite compositions that include copper and acid *at relative concentrations avoided in the prior art*. As mentioned in the specification at p. 2, line 26 through p. 5, line 8 the prior art taught (including the compositions as taught by Reid) that if there were a high acid concentration, then

¹ See also, *In re Soni*, 54 F.3d 746, 34 USPQ2d 1684 (Fed. Cir. 1995) (showing of substantially improved results for invention, and statement that results were unexpected suffices to establish the same absent evidence to the contrary and overcomes a prima facie case of obviousness).

the composition would have a low copper concentration.² The electroplating compositions set forth in claims 1-5, contrary to conventional wisdom and all existing prior art references of record, include relatively high copper to relatively high acid concentrations. Such compositions as claimed were examined and found to provide surprisingly but critically superior fill capabilities, particularly copper deposition bottom-up fill capabilities for high aspect ratio features having submicron dimensions (e.g., 0.12 μ m trenches) such that the presence of voids is reduced or substantially eliminated altogether. See, for example, specific embodiment results shown in Figs. 2(e), 3(d), 4(d), 4(f) and pp. 22-27 of the present application, where particular unexpected superior results of the presently claimed compositions are disclosed.

Comparison Data In the Specification Showed Critically Improved Deposition without Voids Using the Presently Disclosed Compositions while Showing that Prior Art Compositions (virtually identical to what is actually taught by Reid) Results in Unacceptable Voids in the Fill

Applicants performed numerous comparisons with the prior art - some comparisons to almost the identical compositions taught by Reid (i.e., compositions comprising 20 g/L Cu and 180 g/L sulfuric acid³ - Spec. p. 23, ll. 10-12). The results of the prior art composition were a copper fill having unacceptable voids - voids are well-known to be extremely detrimental to the functioning of an integrated circuit (see, e.g., Spec. p. 4, ll. 11-14). As can be seen in reviewing the prior art comparison SEM photograph showing the prior art composition resulting in unacceptable voids in the copper fill (Fig. 6(a)). Even more comparison data is set forth in Examples 2 (spec. p. 23) and Example 3 (spec. p. 24) and is illustrated in the SEM photographs at Figs. 2(a) and 2(c) showing more void fill results when using the Reid-type composition. This comparison data cannot be ignored as it clearly rebuts any *prima facie* case the Examiner alleges exists.

Clearly, in fact Reid specifically *discloses the very prior art that Applicants found unsuitable and thus avoided in developing their new and non-obvious relative ranges of copper to acid compositions.* This is not surprising as Reid was not trying to obtain good results through use of relative copper to acid ranges but instead used conventional high acid/low copper

² Alternatively the prior art taught if you had a high copper concentration, then you must have a low acid concentration.

ranges while including levelers and various cathode current densities to try to avoid having such poor void-prone fills and malfunctioning integrated circuits as a result.

Reid Teaches Conventional Low Copper High Acid Compositions While Teaching Away from Applicants Narrower and Specifically Relative Copper to Acid Range Compositions

In addition, the Reid reference in essence teaches away from the presently claim copper and acid relative ranges by teaching only the conventional low copper/high acid. The bath compositions in the Reid patent example are set out in Table 2, col. 8, where the acid concentrations in each composition is 175 g/l with copper concentrations of 17.5 g/l. This is not just a preferred embodiment of Reid but indeed is the *only embodiment* proposed in the Reid disclosure. **Broad ranges are not an embodiment, they are just that, broad ranges. Thus, they teach only those broad ranges, not specific species relative ranges within that may result in unexpected superior results. What Reid actually teaches, 17.5 g/L Cu and 175 g/L sulfuric acid, are far outside the ranges recited in Applicants' claims 1-5 compositions.** Furthermore, Reid states the importance of the high acid concentration and low copper concentration: "Also important to wetting is the concentration of acid and salt [copper sulfate] in the electroplating bath. High acid levels are effective in quickly dissolving any surface oxides and achieving wetting of the metal onto which subsequent plating must take place." Col. 5, ll. 33-37. The only teaching or suggestion in Reid for a copper to acid range teaches away from Applicants' claimed relative copper and acid concentration ranges.

The Reid '857 Patent Does Not Make Up For the Deficiencies of the Reid '796 Patent

The '857 reference does not make up for the deficiencies of the '796 patent. In fact, it recites the same basic conventional low copper, high acid compositions - reciting three examples (Examples 1-3 at col. 5, l. 54 through col. 6, l. 31) with an acid concentration of 170 g/l and a copper concentration of 18 g/l - again clearly outside the presently claimed composition ranges. Of course, Applicants recognize that the Examiner is not asserting that the '857 patent teaches or suggests the compositions presently claimed. However, for the same reasons set forth above in relation to the '796 patent, the '857 patent, whether considered independently or in combination

³ Reid's only disclosed relative range or amount of Cu to acid was 17.5 g/L Cu to 175 g/L sulfuric acid (Col. 8, Table 2), which is virtually identical to the prior art comparison conducted for the present application.

with the '796 patent, neither teaches nor suggests the compositions of present claim 1. Thus, Applicants respectfully request that the rejection to claims 1-5 be withdrawn as the Examiner's obviousness rejections have been rebutted.

Claims 2-5 are also allowable over the art of record based on the unique and non-obvious combinations of features disclosed in each of those claims. For example, in present claim 3, a concentration of about 2 to about 30 ml/l of accelerator is recited. The only specific disclosures (other than the broad ranges disclosed in Table 1 in the '796 patent) teach and suggest an accelerator concentration of 1 ml/l - outside the presently claimed range.

Claims 6-14 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Reid USP 6,024,857. This rejection is traversed.

Claims 6-14 are allowable over the art of record for the same reasons as set forth above in relation to claims 1-5 and based on each of those claims unique and non-obvious combination of features. Thus, Applicants respectfully request that the rejections to claims 6-14 be withdrawn.

Claims 15-18 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Reid USP 6,024,857. This rejection is traversed.

Claims 15-18 are allowable over the art of record for the same reasons as set forth above in relation to claims 1-5 and based on each of those claims unique and non-obvious combination of features. Thus, Applicants respectfully request that the rejections to claims 15-18 be withdrawn.

Claims 19-25 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Reid USP 6,024,857. This rejection is traversed.

Claims 19-25 are allowable over the art of record for the same reasons as set forth above in relation to claims 1-5. Claims 20-25 are also allowable over the art of record based on the unique and non-obvious combinations of features disclosed in each of those claims. Thus, Applicants respectfully request that the rejections to claims 19-25 be withdrawn.

Claims 26-33 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Reid USP 6,024,857. This rejection is traversed.

Claim 26 (and dependent claims 27-33) of the present application recites in part, a composition comprising an aqueous mixture of copper and sulfuric acid wherein the ratio in g/L of solution of copper to acid is equal to about 0.4 to about 0.8. This carefully defined range of ratios is not taught or suggested by the prior art.

The only ratio taught or suggested in Reid is 17.5 g/L Cu to 175 g/L of sulfuric acid (col. 8, Table 2). This is a ratio (0.1) outside the claimed range. Thus, no prima facie case of obviousness has been shown. Even if one were to, for the sake of argument, consider there has been such a showing, for the same reasons as discussed above in relation to claims 1-5, any possible obviousness showing has been rebutted with evidence of unexpected superior critical results. The Reid patent discloses the very prior art that Applicants differentiate both in their specification (see, e.g., p. 8, ll. 24-29 and all the comparison analysis data) and the present claims. Reid neither teaches nor suggests the presently claimed compositions and thus the rejection of claims 26-33 should be withdrawn (and should be withdrawn based on each claim's unique and non-obvious combination of features as well).

Also as discussed above, the '857 reference does not make up for the deficiencies of the '796 patent. In fact, it recites the same basic convention low copper high acid compositions - reciting three examples (Examples 1-3 at col. 5, l. 54 through col. 6, l. 31) with an acid concentration of 170 g/l and a copper concentration of 18 g/l - again clearly outside the presently claimed ratio range of 0.4 to 0.8. Examples 1-3. Of course, Applicants recognize that the Examiner is not asserting that the '857 patent teaches the compositions presently claimed. However, for the same reasons set forth above in relation to the '796 Reid patent, the '857 Reid patent, whether considered individually or in combination with other references, neither teaches nor suggests the compositions of present claim 26. Thus, Applicants respectfully request that the rejection be withdrawn.

Claim 34 is rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796. This rejection is traversed.

Claim 34 recites in part, a composition comprising an aqueous mixture of copper and sulfuric acid wherein the ratio in g/L of solution of copper to acid is equal to about 0.3 to about

0.8. Accordingly, claim 34 is allowable for similar reasons as set forth above in relation to claims 1 and 26.

Claims 35-43 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Reid USP 6,024,857. This rejection is traversed.

Claim 35 recites, in part, an aqueous mixture of copper and sulfuric acid wherein the copper concentration in the composition is within about 60% to about 90% of its solubility limit when the sulfuric acid concentration is from about 65 to about 150 g/L.

Nothing in Reid teaches or suggests including copper in sulfuric acid at 60-90% of its solubility limit and the Examiner cites to no teaching or suggestion of such in Reid. The one Reid cite showing an actual copper to acid ratio as referred to by the Examiner (e.g., col. 8, Table 2) teaches a composition where copper is well below 60% of its solubility limit. This can be verified by reviewing solubilities of copper in acid or by simply reviewing Fig. 1 of Applicants' specification where such solubility limits are graphed.

Accordingly, no *prima facie* case of obviousness has been presented for claims 35-43 and thus the rejection must be withdrawn. Claims 36-43 are also allowable over the art of record based on the unique and non-obvious combinations of features disclosed in each of those claims. For example, in present claim 37, a concentration of about 2 to about 30 ml/l of accelerator is recited. The only specific disclosures (other than the broad ranges disclosed in Table 1 in the '796 Reid patent) teach and suggest an accelerator concentration of 1 ml/l - outside the presently claimed range.

Claims 44-52 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Reid USP 6,024,857. This rejection is traversed.

Claim 44 (and dependent claims 45-52) of the present application recites in part, a composition comprising about 40 g/L copper and about 100 g/L sulfuric acid. Claims 44-52 are allowable over the art of record for the same reasons as set forth above in relation to claims 1-5. Claims 44-52 are also allowable over the art of record based on the unique and non-obvious combinations of features disclosed in each of those claims. Thus, Applicants respectfully request that the rejections to claims 44-52 be withdrawn.

Claims 53-54 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Reid USP 6,024,857. This rejection is traversed.

Claim 53 (and dependent claim 54) of the present application recites in part, a composition comprising about 50 g/L copper and about 80 g/L sulfuric acid. Claims 53 and 54 are allowable over the art of record for the same reasons as set forth above in relation to claims 1-5. Claim 54 is also allowable over the art of record based on the unique and non-obvious combinations of features disclosed. Thus, Applicants respectfully request that the rejections to claims 53 and 54 be withdrawn.

Claims 55-56, 60 and 62 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Uzoh, US Pub. No. 2002/0033342. This rejection is traversed.

Claim 55 of the present application recites in part, a method for plating a workpiece utilizing an electroplating composition comprising about 35 to about 60 g/L copper and about 65 to about 150 g/L sulfuric acid. Again, for the same reasons as discussed above, Reid neither teaches nor suggests utilizing such a composition.

Uzoh does not make up for the deficiencies of the Reid patents as Uzoh neither teaches nor suggests utilizing compositions as recited in Applicant's claims. Of course, Applicants recognize that the Examiner is not asserting that Uzoh teaches the methods utilizing the compositions presently claimed. However, Uzoh, whether considered individually or in combination with Reid, neither teaches nor suggests the compositions utilized in the methods of present claim 55. Thus, Applicants respectfully request that the rejection be withdrawn.

Claims 56, 60 and 62 are dependent upon claim 55 and thus are allowable over the art of record as well. Claims 56, 60 and 62 are also allowable over the art of record based on the unique and non-obvious combinations of features disclosed in each of those claims. For the reasons set forth above, Applicants respectfully request that the rejections of claims 55-56, 60 and 62 be withdrawn.

Claims 57, 59 and 61 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Uzoh, US Pub. No. 2002/0033342 and Basol USP 6,733,063. This rejection is traversed.

Basol does not make up for the deficiencies of the Reid patents as Basol neither teaches nor suggests utilizing compositions as recited in Applicant's claims. Applicants recognize that the Examiner is not asserting that Basol teaches the methods utilizing the compositions presently claimed. However, Basol, whether considered individually or in combination with Reid and the Uzoh reference, neither teaches nor suggests the compositions of present claims 57, 59 and 61.

These claims are allowable over the '796 patent and Uzoh for the same reasons as discussed immediately above in relation to claim 55. Because Basol does not make up for the deficiencies of Reid and Uzoh, Applicants respectfully request that the rejections be withdrawn.

Claims 63-65 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Reid USP 6,024,857. This rejection is traversed.

For the same reasons as set forth above in relation to claims 1-5 and subsequent claims/arguments regarding the same, these references neither teach nor suggest (whether considered individually or in combination) the methods disclosed in claims 63-65. Accordingly, Applicants respectfully request that the rejections be withdrawn.

Claims 66 and 67 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Wilson, US Pub. No. 2005/0178667. This rejection is traversed.

Claim 66 of the present application recites in part, a method for plating a workpiece utilizing an electroplating composition comprising about 35 to about 60 g/L copper and about 65 to about 150 g/L sulfuric acid. Again, for the same reasons as discussed above, Reid neither teaches nor suggests utilizing such a composition.

Wilson does not make up for the deficiencies of the Reid patents as Wilson neither teaches nor suggests utilizing compositions as recited in Applicant's claim 66. Applicants recognize that the Examiner is not asserting that Wilson teaches the methods utilizing the compositions presently claimed. However, Wilson, whether considered individually or in combination with the Reid patents, neither teaches nor suggests the compositions utilized in the

method of present claim 66. Thus, Applicants respectfully request that the rejection be withdrawn.

Claim 67 is dependent upon claim 66 and thus is allowable over the art of record as well. Claim 66 is also allowable over the art of record based on the unique and non-obvious combinations of features disclosed in the claim. For the reasons set forth above, Applicants respectfully request that the rejections of claims 66 and 67 be withdrawn.

Claims 68 and 69 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Reid, USP 6,793,796 in combination with Wilson, US Pub. No. 2005/0178667. This rejection is traversed.

Claim 68 of the present application recites in part, a method utilizing a composition comprising a mixture of copper and sulfuric acid wherein the ratio in g/L of solution of copper to acid is equal to about 0.4 to about 0.8. As discussed above in relation to other claims (e.g., claim 26), no *prima facie* case of evidence has been presented as the Reid patent neither teaches nor suggests utilizing a composition having any copper to acid concentration ratio other than 0.1, which is far outside the claimed range of copper to acid concentration ratios.

Claim Rejections under 35 USC § 103(a) Based on Primary Reference Grandikota

Claims 1-69 are rejected under 35 USC § 103(a) as allegedly being obvious in view of Grandikota, Published US Pat. App. No. 2002/0112964 in combination with Gabe Published US Pat. App. No. 2003/0066756 (and others). This rejection is traversed.

Nothing in Grandikota teaches or suggests the claimed composition of about 35 to about 60 g/L copper and about 65 to about 150 g/L sulfuric acid. Grandikota teaches that a high copper concentration (reciting - as cited by the examiner - 3--55 g/L copper) requires a low acid concentration ([0018 at lines 19-21]) and thus recites an acid range below the higher acid range recited in the present claims, i.e., 6-60 g/L (also as cited by the Examiner). This reference neither teaches nor suggests the acid range claimed in any of the presently considered claims of the current application and the rejection is improper. Indeed, this reference substantiates all the comments made above regarding the prior art teaching either a high copper/low acid or a low copper/high acid but never the relative recited ranges as currently claimed. Further, the other

portion of this reference cited by the examiner (i.e., [0016] especially lines 7-8) recites an acid concentration of only 4-10 g/L -- far below the presently claimed 65-150 g/L sulfuric acid.

The other references do not make up for the deficiencies of Grandikota, nor does the Examiner assert that they do. Clearly the Grandikota reference neither teaches nor suggests the presently claimed compositions or methods in any of the claims 1-69 and further discussion of the reference to further expose the deficiencies of the same is unnecessary. The rejections should be withdrawn.

If the Examiner has any questions or concerns regarding the present application, the Examiner is invited to contact Applicant's counsel at the telephone number set forth below

Respectfully submitted,

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